during twenty years, and with many of which the readers of NATURE have been made familiar from time to time.

The basis of these experimental researches is the *secondary battery*, originally devised by Ritter, but which in M. Planté's hands has become developed into what is practically a new and important source of electricity. M. Planté, by employing for his secondary cells large plates of lead immersed in dilute sulphuric acid, charged by a small Bunsen's or Grove's battery, and by arranging the secondary cells in such a manner that they can be charged in multiple arc, and discharged in series, obtains during the ten minutes or so during which the discharge continues currents not only of as great electromotive force as would be obtained from a Grove's battery of a much larger number of cells, but also of much greater "quantity;" the internal resistance of these secondary cells being excessively small.

In studying the construction and operation of these secondary batteries, M. Planté has brought to light a large number of interesting facts. He finds that such batteries improve with use, the two lead electrodes gradually becoming spongy, thereby holding in loose combination larger quantities of the oxygen and hydrogen gases, respectively, than new plates of lead. He observes several highly suggestive analogies between this electro-chemical accumulation of the energy of the current, and the electrostatic accumulation of the Leyden jar. This analogy extends even to the existence of a residual charge. It appears that the electromotive force of such a cell well charged may be as high as 2·7187 volts, while the internal resistance may be as low as 0·05 ohm, and that the actual quantity of the primary current which may be realised after being thus accumulated amounts to 88 per cent. These data are given amongst the stores of information in the first section of M. Planté's work. The second section treats of the practical uses which have been made by M. Trouvé and others of the currents from secondary batteries, and which embrace a wide range of applications, chief amongst which is the application to surgical cautery by means of wires raised to a white heat, for which operation a powerful current of short duration only is required. Another suggestion, to employ such batteries as accumulators of the current supplying electric lights, has already been seized upon by more than one inventor, amongst others by Mr. Edison.

The third section of the work before us deals with sundry phenomena produced by the discharge of the powerful currents of large secondary batteries. To obtain these effects M. Planté has used batteries of from 200 to 800 secondary elements. Luminous liquid globules and delicate flame-like aureoles are produced at the surface of liquids when the current is led into them under certain conditions: even a globule of fused mica has been produced by the current, and wandered about in a manner suggestive of the alleged behaviour of the "balls of fire" sometimes accompanying violent thunderstorms. The discharge may even be employed to write upon glass which is etched away under the negative pole of the secondary battery. The many analogies presented by these experiments with some of the less understood of natural phenomena, globular lightning, auroræ, and wreathed lightning discharges, &c., are treated in detail in the fourth section. M. Planté considers the "Fire of Saint Elmo" to be a phenomenon of discharge of negative electricity, whilst he compares the globular lightning to the phenomena observed in the discharges at the positive pole of his batteries. One of the most curious of his speculations is that concerning the spiral nebulæ, which he compares with the spiral forms produced at the negative pole when dilute acid is electrolysed by a moderately strong current between copper electrodes in the presence of a powerful electromagnet. These "electrodynamic" spirals consist of streams of particles of oxide of copper whirled off from the end of the electrode and which, conducting the current, undergo a rotatory displacement under the influence of the neighbouring magnet. These spirals, which therefore indicate the lines of flow of the current, resemble the spirals obtained by the present writer in iron filings under the joint influence of a magnet and a current traversing it longitudinally, and which differed from those of M. Planté in indicating lines of magnetic induction, not lines of current flow. So strongly does the analogy of form weigh with M. Planté that he asks (p. 243) whether the nucleus of a spiral nebula is not truly an "electric focus," and "whether the spiral form is not probably determined by the presence in the neighbourhood of strongly magnetised heavenly bodies!" Another astronomical analogy is discovered by the author between the sun-spots and certain "crateriform perforations" which are produced in moistened paper beneath the positive pole of the secondary battery.

The fifth, and last part of the work, explains the construction and operation of the author's "rheostatic machine," which is a series of mica condensers which are charged in multiple arc from a battery of 600 or 800 secondary elements, and discharged in series in very rapid succession. This instrument is capable of producing almost continuously the effects of intense discharges of statical electricity, and promises to prove of great utility as an instrument of research.

We have preferred to give the reader a brief *résumé* of the contents of this delightful narrative of researches, rather than to criticise in detail the many salient points which it presents. Experimental researches of the present day are seldom conducted with such patient and ingenious endeavour as those now published in M. Planté's volume. The student of electrical theory will find in them but little that he did not know before. The phenomenal not the theoretical aspect of the question is ever uppermost; and in default of theory there is a tendency to ride *the analogies* too hard. But none can help admiring the beauty and originality of the experiments here recorded, nor doubt the very high value of the results obtained. There will, too, be many readers who will long that all treatises on experimental science were written in so clear, concise, and elegant a style as that of the author.

SILVANUS P. THOMPSON

NATURAL HISTORY OF THE ANCIENTS

Gleanings from the Natural History of the Ancients. By the Rev. W. Houghton, M.A., F.L.S. Illustrated. (London: Cassell, Petter, and Galpin, 1880.)

THIS interesting volume consists of a series of short lectures treating of most of the animals known to the early inhabitants of Egypt, Palestine, Assyria, Greece,

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and Rome, from the oldest historic period down to about the middle of the third century of the Christian era. Referring to his sources of information the author expresses his acknowledgments to the Biblical and Assyrian records and the classical writers of Greece and Rome. Alluding to Aristotle's work, "The History of Animals," he quotes Lewes's well-known remarks thereon, which, while he will not fully endorse, he yet on the whole agrees with.

The author warns the reader not to expect an exhaustive treatise on the subject; the avowed object, as the title indicates, being but gleanings picked up almost at random from a spacious field; indeed, a volume quite as large might be written on only those domestic animals known to the ancients. If not a complete history, these "Gleanings" are, however, very pleasant reading, deeply interesting to the intelligent student, and making him wish for more. In some cases a little more information would be useful, and we would venture to suggest to the author that in another edition he might with advantage add more details about the very early history of some of the best known of the animals which he has selected for notice. Thus the Egyptians were the only people amongst the ancients who habitually domesticated the common cat; with them it was a great favourite, and we would certainly have liked a little more of what the author could have told us about the cat as it is found in an Egyptian home; had it a pet name there? and is it not strange that the children of Israel do not seem to have come across it during their lengthened sojourn in that strange land? In another edition the references should be quoted at greater length; thus the general reader could scarcely be expected to know that the translation of Prof. Gubernati's interesting work on "Zoological Mythology" is referred to as "Guber. Zool. Myth."

The Egyptian dog is acknowledged by the author not to come up to the standard of modern European views of canine beauty; but he is not so severe on them as Mr. Mahaffy, in whose eyes the house-dogs appear to have been worthless curs, and the hunting-dogs more like those lanky creatures kept by some of the Irish peasantry for an occasional Sunday coursing match (Mahaffy, "Prolegomena of Ancient History"). The author states that the Egyptian monuments anterior to the date of Amosis (about B.C. 1500), of the eighteenth dynasty, give no representation of horses, but considers it would not be safe to conclude from negative evidence that the horse was not introduced into Egypt anterior to that date. Leaving the date of the papyrus Sallier to be settled by experts, but presuming it from Mr. Goodwin's Essay ("Cambridge Essays," 1858) to relate to events about the time of the Exodus, we find such allusions as "The horses of my lord are well," and "His ploughshare, which is of metal, corrodes, the horses die through the labour of ploughing;" the latter is very remarkable for being part of the complaint of an agricultural tenant; these would show that at this date—possibly the date of the years of famine—horses, were then employed in field work.

The common pig formed part of the farmyard stock of the Egyptians, and the author thinks that they were kept as probably useful in treading in the corn after it was sown, and he quotes Herodotus and Ælian as describing the process; neither author says anything about the pigs being muzzled when performing this useful part, but they are shown as such on a Theban sculpture referred to.

The section about the pigeons might be greatly expanded; there is next to nothing told us about the pigeon as known to the Egyptians and Hebrews, and though there is a woodcut from an Assyrian sculpture showing hare and birds, yet there is not a word in the text as to the hare being known to the Hebrews and Assyrians.

The second part of the volume on wild animals is nearly equally interesting as the first. In it we read of the lion, hyena, stag, wild bulls, boar, vulture, pelican, ostrich, and many other birds, as well as of several species of fish, known in the olden times.

OUR BOOK SHELF

Bulletin des Sciences Mathématiques et Astronomiques. Deuxième serie, tome iii., avril 1879. (Paris.)

THIS number opens with abstracts of works by H. Lemonnier ("Mémoire sur l'Élimination," Paris, 1879); E. Schering ("Analytische Théorie der Determinanten," Göttingen, 1877); and an interesting note by S. Kantor ("Quelques Théorèmes nouveaux sur l'Hypocycloide à trois Rebroussements"). Our present object is, however, to take notice of two long articles by M. G. Darboux, (*a*) "Sur un nouvel Appareil à Ligne droite de M. Hart" (7 pp.) (*β*) "Recherches sur un Système articulé" (42 pp.).

(*a*) is founded on a five-bar linkwork, described by Mr. Hart in the eighth volume of the *Proceedings* of the London Mathematical Society (p. 288), which M. Darboux looks upon as a construction of great interest. The writer explains Mr. Hart's method and slightly generalises it, getting the following results: (1) an ellipse and Pascal's limaçon can also be described by the linkwork; (2) a movement of a straight line which always remains horizontal whilst its several points describe vertical straight lines. By means of a duplication of the apparatus, "on pourra poser une table sur ces droites, et l'on aura ainsi la disposition la plus simple connue, permettant de réaliser un mouvement parallèle dont les applications sont évidemment très-variées."

(*β*) is a discussion of Mr. Kempe's "recherches très-interessantes" "On Conjugate Fourpiece Linkages" in the ninth volume of the *Proceedings* of the same Society (pp. 133-147). M. Darboux remarks that Mr. Kempe has considered one interesting case only, that, viz., "où les équations sont des identités et où par conséquent la déformation de la figure est possible." He praises the ingenuity of the method employed, and says that Mr. Kempe has arrived at a large number of solutions of a problem which, *à priori*, would be thought to have none. He then proceeds to attack the question in a more general manner, connecting the problem with the use of Mr. Hart's apparatus, referred to in his paper (*a*). "La marche qui j'ai adoptée repose d'une part sur l'emploi des *grandeurs géométriques* dans le plan et sur leur expression bien connue au moyen d'une variable complexe, et d'autre part sur les recherches que j'ai publiées récemment[1] et d'après lesquelles la théorie du quadrilatère articulé est identique à celle d'une cubique plane, que j'appellerai *cubique associée au quadrilatère.*"

Denoting the outer quadrilateral of Mr. Kempe's figure by $MNPQ$, and the inner by $M'N'P'Q'$, M. Darboux calls them respectively the quadrilaterals T, U, and the associated cubics he calls the cubics T, U, and taking $t, t', t'', t''', u, u', u'', u'''$ as the co-ordinates of a point in space with reference to the two cubics, he finds the conditions that a certain group (4) of equations between these co-ordinates shall be satisfied by an infinite number of values of the t's and u's. He regards these equations, when the movement of the figure is possible, as establish-

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[1] P. 109 of the *Bulletin* for March. 1879.

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